Metal surfaces with holes in them: new plasmonic metamaterials

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Since the pioneering experiment of Ebbesen *et al.* [1] reporting extraordinary optical transmission (EOT) through 2D hole arrays perforated in optically thick silver films, the optical properties of subwavelength apertures has become a very active area of research in electromagnetism. From the beginning, this phenomenon was explained in terms of the resonant excitation of surface plasmons that decorate the two metal-dielectric interfaces. In recent years, we have demonstrated that EOT is a more general phenomenon appearing in, for example, corrugated photonic crystal surfaces [2] or in 1D-structured metal surfaces for *s*-polarization (i.e., without plasmons) [3]. It is clear now that the only ingredients that are necessary in order to observe EOT is the existence of a surface EM mode and a corrugation allowing the coupling of the incident wave to this mode.

Surprisingly, we also found that an array of subwavelength holes in a perfect conductor also gave rise to EOT even though the free surface of an unperforated perfect conductor has no surface modes. We have recently cleared up this paradox [4,5] by showing that corrugation (with holes or dimples or grooves) of perfect conductor surfaces originates surface EM modes with a plasmon-like (so called *spoof* plasmons) behavior. Importantly, the dispersion relation of these *spoof* plasmons is mainly dictated by the geometry of the indentations (size and separation) opening the possibility of tailoring the properties of these modes in order to control the flow of light in the surface of a metal.

References

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